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INTERACTION BETWEEN TERMITES AND PLANTS — AN OVERVIEW

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ABSTRACT

In the biological interaction between plants and animals it is well known that, of the insects, the termites play a very prominent and significant role since they are able to transform dead and decaying complex plant cellulosic material into reusable soil nutrients which in turn are used by future generations of plants. These little insects are also responsible for much of the turning over of the soil by bringing up fresh soil from below the earth surface. Termites are mainly herbivorous and also saprophagous and so are deeply involved in the dissimilation of nutrients from deadwood and decomposed vegetation holding an important position in the ecosystem in tropical countries and in warm temperate zones. As these insects rely on micro-organisms, living in a state of symbiosis inside their gut canal for the digestion of complex plant material the whole process of interaction is very much more complicated and many factors have to be taken into account such as the biology of the host termites, their intestinal protozoans and bacteria as well as the food inself which may be in a living condition or in a decaying and dead condition.

ROLE OF TERMITES IN THE ECOSYSTEM

Some important studies have been carried out in other countries on the role of termites in the ecosystem and as processors of plant material which are fairly significant. It is very true that any dead wood lying in an undisturbed piece of either forest bed or field is fairly soon attacked and covered over by mud by the termites, so that the moment that mud covered piece is touched it crumbles with nothing of the wood left inside. The food thus eaten gives nourishment to the termite itself and thence forward to the colony and forms the base of this inter action. On the other hand the dissimilated particles mingle with the earth to begin a new cycle. The faecal matter in some termites is used for lining their galleries and walls of nest chambers or for building their nest systems so the faecal matter as also the mounds or nests are not immediately available for other soil organisms or plants, but in the long run are returned to the soil.

Many factors including physical and mateorological and also the degradative actions of fungi and other microorganisms help to make wood edible to the termites, after which the ingested food is further degraded by microorganisms before it is finally absorbed. All this goes to show the intimate relationship between plants and the primary consumers, the termites, which use all types of wood, humus and soil for their own nutrition and then again returning them to the soil in a slightly different if perhaps better form subsequently.

FEEDING BEHAVIOUR OF INDIAN TERMITES

To analyse the interaction between plants and in this case the termites, we have to take into account the various food sources of the insect, almost all of which are plant based since the termites are essentially herbivores, rarely attacking dead animal tissues or furs and feathers. The food of these insects is classified thus :

(a) *Living:* Tree trunks and branches, young saplings and roots.

(b) *Dead:* Standing tree stumps, dead branches, roots, and newly fallen trees; dead grasses, herbs and shrubs; dead leaves and twigs lying on ground surface; rotten, dead and decaying vegetation matter; plant litter and humus; and other cellulosic material.

The termites of families Kalotermitidae, Termopsidae, Hodotermitidae, Rhinotermitidae and Stylotermitidae feed on sound wood of a large number of species of plants and on grasses but there is no host specificity. The Kalotermitidae, essentially the wood-inhabitating termites, may feed on dead portion of trees and also on live tissue adjacent to the damaged portions or on dead wood. The termopsidae, of which only a single species *(Archotermopsis wronghtoni)* is found in the Indian region, are damp-wood feeding termites and Hodotermitidae, represented by a few species of the genus *Anacanthotermes* in Indian region, are grass feeders. The Rhinotermitidae though, have their main nests in soil, are reported to feed on living trees, wood and converted woods as in case of Kalotermitidae. The Stylotermitidae (genus *Stylotermes)* also feed on dead and live tissue of trees. The Termitidae feed on dead woods broken up by fungi and other organisms, soil and humus and on other wooden structures. As there is no host specificity there is only an indirect interaction between the plants and termites.

INTERACTION BETWEEN TERMITES, PROTOZOA AND PLANTS

Termites feed on wood and other cellulosic materials which can not generally be assimilated, and so the termites harbour Protozoa in the hindgut to help them in digestion of cellulose thus exhibiting a true example of mutualism between Protozoa and termites. The role of Protozoa in this type of digestion is indispensable for the survival of these insects and this interaction between the termites, Protozoa and wood has been a very interesting subject of study. The mastigophora of orders Oxymonadida, Trichomonadida and Hypermastigida are restricted to lower families of termites viz. Mastotermitidae, Hodotermitidae, Termopsidae, Kalotermitidae and Rhinotermitidae. Termitidae usually do not feed solely on wood and, therefore, in general do not harbour any Protozoa and if at all present, their role is not mutualistic and they are not different from those found in other insects, invertebrates or even vertebrates.

INTERACTION BETWEEN TERMITES AND FUNGI

A large number of fungus species, belonging to almost all the classes of fungi, have been reported from the habitations of termites. Their role may be beneficial to the community as they help in the breaking up of cellulosic contents or they may be parasitic or pathogenic. Symbiotic relationship between the Macrotermitinae and the fungal genus *Termitomyces* represents the highest degree of interaction between the termites and fungi. Of course the lower termites harbour symbiotic Protozoa which help in the digestion of wood and other cellulosic materials as mentioned above but on the other hand the fungi, break up the cellulose and lignin in the wood upon which the higher termites feed or rather prefer to feed. Thus this role of fungi is very important to higher termites.

Some of the fungi such as cubical brown-rot fungus, *Lentinus pallidus* has been reported to break down the harmful and toxic repellents in *Pinus caribaeu* in British Honduras thus making it a preferred feeding and nesting site for the termite

Coptotermes niger Snyder. The white-rot fungi also break down lignin in wood, making some carbohydrate available to termites. It has been demonstrated experimentally that the repellent-extracted wood helps in longer survival of this termite species thus showing the preference of wood from which the toxic repellents have been broken down by the white-rot. Experiments conducted in the laboratory to test the influence of different strains of fungi on the longevity of termites have also shown that the effects of some are favourable and of some harmful.

A large number of species of fungi have been reported from termite nests but very few of these are saprophytes. Species of genera *Xylaria, Peziza, Podaxon* and *Neoskofitzia* are reported growing out of abandoned fungus combs. A few Basidiomycete saprophytes have been reported from Madagascar but from nowhere else.

Some of the more common parasitic fungi belong to the genera *Laboulbenia, Termitaria* and *Antennopsis* and are reported to infest skin and other body parts of certain termites and even enter through the alimentary canal, invade fatty tissues and emerge out breaking the exoskeleton. The true pathogenic fungi records are very few.Some species of Phycomycetes genera *Entomophthora* and *Sporotrichum* have been reported as pathogens and some experimental studies have also been conducted in laboratory to test the pathogenic nature of some. Basidomycetes genus *Termitomyces* lives in symbiosis with Macrotermitinae. They grow on the fungus combs of the termites and in turn help in breaking down of lignin and supply of nitrogenous materials and vitamins. The combs, however, are used as nurseries, produce heat and maintain constant humidity and temperature in the termitaria.

Fungus in decaying vegetation is also ingested by the termites and so it is also used as a food.

The earliest record of fungus gardens in mounds is that of König (1779) who noted them in the mound of probably *Odontotermes redemanni,* in southern India. There are further records of fungi associated with termites by Petch (1906, 1913), Bose (1923) and Batra and Batra (1966) in different termite species from the Indian Region but no work has been undertaken on their role in the life of termites.

SOME SUGGESTIONS FOR FUTURE STUDIES

Termites, play a very important role in the ecosystem and their interaction with plants is of great significance since they are essentially herbivorous. Some useful work on the taxonomy of Indian termites has been done during the last few years but studies on interaction between termites and plants needs more attention. The following lines of future studies, are suggested so that we have better knowledge of the termite-plant interaction :

1. A thorough survey of termite associated fungi.
2. Taxonomy of Protozoa associated with termites.
3. Physiological aspects of digestion of plant tissue and wood in termites.
4. Role of fungi in breaking up of cellulose and lignin in dead wood.
5. Role of termites in different ecosystems.

The recent reviews by Wood (1978) on the feeding behaviour of termites, by Wood and Sands (1978) on the role of termites in ecosystems, by Sands (1969) on termite-fungi association and by Honigberg (1970) on termite-associated Protozoa; and studies of Roonwal and Chhotani (1961, 1967) on wood-destroying termite, Roonwal (1979) on "Termite Life and Termite Control in Tropical South Asia" and Chhotani (1980) on "Termite Pests of Agriculture in the Indian Region and their Control" provide useful literature for studies on these subjects.

REFERENCES

BATRA, L.E. AND S.W.T. BATRA. Fungus growing termites of tropical India and associated fungi. *J. Kansas ent. Soc.* 39 : 725-738. 1966.

BOSE, S.R. The fungi cultivated by the termites of Barkuda. *Rec. Indian Mus.* 25 253-258. 1923.

CHHOTANI, O.B. Termite pests of agriculture in the Indian Region and their control. *Tech. Monogr. Zool. Surv. India,* No. 4 . 1-94, 7 pls. 1980.

HONIGBERG, B.M. Protozoa associated with termites and their role in digestion 1-36. In : *Biology of Termites* vol. 2 (Eds. K. Krishna and F.M. Weesner). Academic Pr., New York. 1970.

PETCH, T. The fungi of certain termite nests *(Termes redemanii* Wasm. and *T. obscuriceps* Wasm.).*Ann. Roy. Bot. Gard. Peradeniya* 3(2) 185-270. 1906.

—— White ants and fungi. The black termite *(Eutermes monoceros* Koen.) of Ceylon. *Ibid.* 5 : 389-420. 1913.

ROONWAL, M.L. *Termite Life and Termite Control in Tropical South Asia.* viii + 177 pp., 8 pls. (Scientific Publishers, Jodhpur). 1979.

—— AND O.B. CHHOTANI. The more important wood destroying termites of India : 89-96. *Proc. Symp. Timber & Allied Products* (New Delhi, May 1959) (National Building Organisation). 1961.

—— AND —— Indian Wood-destroying termites. *Journ. Bombay nat. Hist. Soc.,* 63(2) : 354-364. 1967.

SANDS, W.A. The association of termites and fungi : 495-524. In *Biology of Termites,* vol-1 (Eds. K. Krishna and F.M. Weesner). Academic Pr New York. 1969.

WOOD T.G. Food and feeding habits of termites 55-80. In : *Production Ecology of Ants and Termites (International Biological Programme 13)* (Ed. M V. Brian). Cambridge Univ. Pr. 1978.

—— AND W.A. SANDS. The role of termites in ecosystems : 245-292. In *Ibid.* 1978.